

CHANDRA POWER SYSTEM STATUS

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April 19, 2005

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Chandra's Mission

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The Chandra X-Ray Observatory combines an efficient high resolution X-ray telescope with a suite of advanced imaging and spectroscopic instruments for the study of X-ray astronomy

Customer: NASA

Launched: 23 July 1999

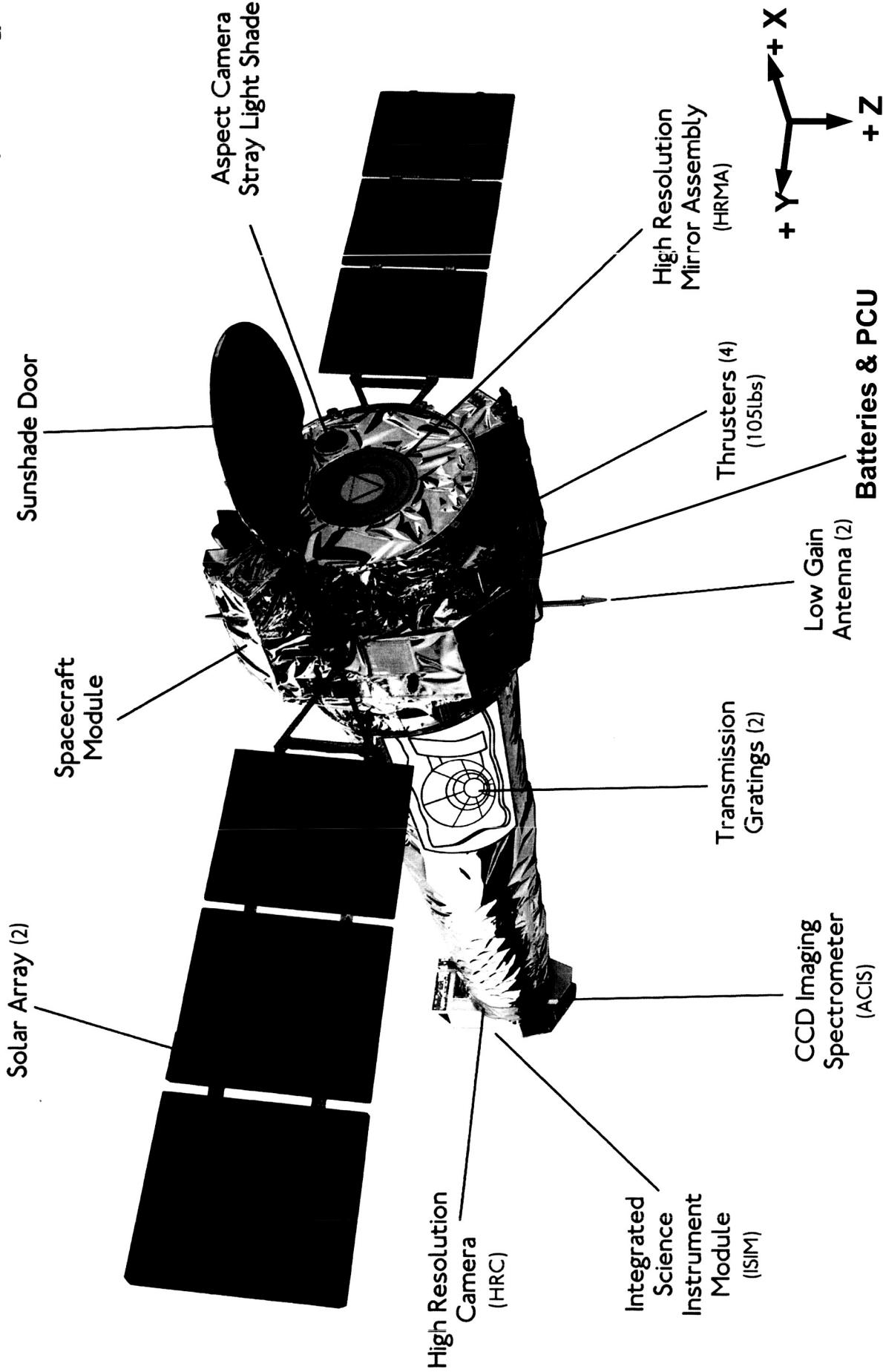
Life expectancy: 5 years (minimum)

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Spacecraft Configuration

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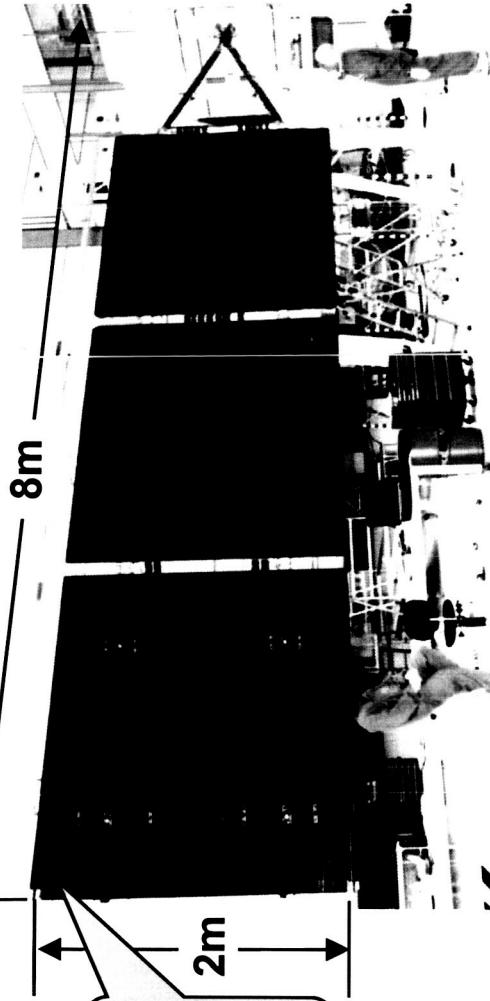
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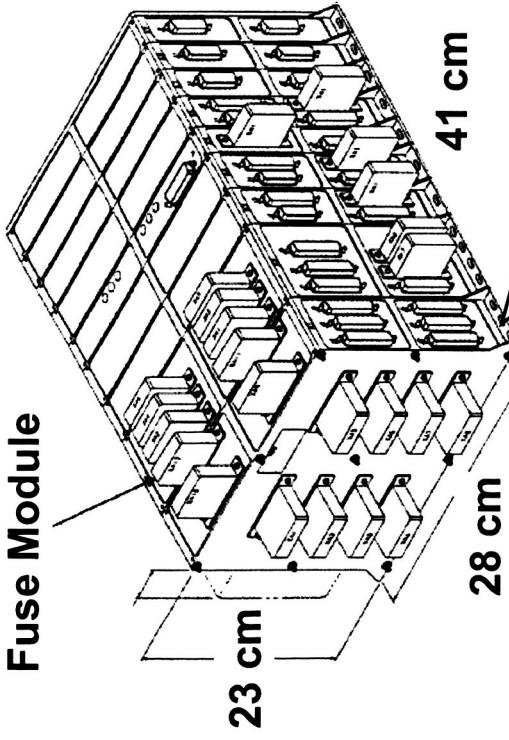
EPS Components

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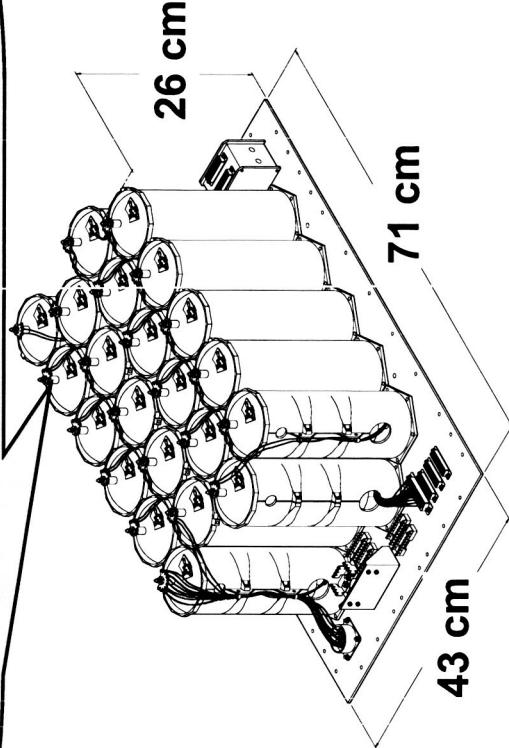
Two Identical Wings (3 panels each)
~15000 Si Cells (12.2% efficiency)
Electrical Design, Lay-down by NGST
Mechanical Design by Dutch Space
Mechanical Heritage to Telecom 2

Fuse Module



One Power Control Unit (PCU)

3 NiH₂ Batteries (3 for 2 Redundancy)
22 cells @ 40 Ahrs



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Topology and Block Diagram

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RTCU

LOADS

External Power enters the system and is connected to the **PCU** and the **SADA** (Solar Array Drive Assembly).

The **PCU** is connected to the **Main Bus** and the **SADA**.

The **SADA** is connected to the **Main Bus** and the **External Power**.

The **Main Bus** is connected to the **PCU**, **SADA**, **K1, K2, K3**, **K6**, **K4, K5**, and the **BATTERY**.

The **BATTERY** (2 Cells, 1 of 3) is connected to the **Main Bus** and the **Reconditioning Circuits**.

The **Reconditioning Circuits** (1 of 3) are connected to the **Main Bus** and the **SPG**.

The **SPG** is connected to the **Main Bus**.

The **Main Bus** is connected to the **Load String (68 Cells)** and the **1 of 192** switch.

The **Load String (68 Cells)** is connected to the **External Power** and the **1 of 192** switch.

The **1 of 192** switch is connected to the **Trickle Charge Lower Section (69 Cells)**, **Full Charge Lower Section (69 Cells)**, and the **1 of 5 x 3** switch.

The **Trickle Charge Lower Section (69 Cells)** is connected to the **External Power** and the **1 of 5 x 3** switch.

The **Full Charge Lower Section (69 Cells)** is connected to the **External Power** and the **1 of 5 x 3** switch.

The **1 of 5 x 3** switch is connected to the **Trickle Charge Upper Section (34 Cells)**, **Full Charge Upper Section (34 Cells)**, and the **SPG**.

The **Trickle Charge Upper Section (34 Cells)** is connected to the **External Power** and the **SPG**.

The **Full Charge Upper Section (34 Cells)** is connected to the **External Power** and the **SPG**.

Direct Energy Transfer; Battery Clamped Bus

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Power Control

• Eclipse Operations

- Batteries are sized such that 2 of 3 batteries could support a 844 W avg. load during a 2 hour eclipse at a Depth of Discharge (DOD) $\leq 80\%$
- 2 minutes prior to eclipse entrance, all 3 batteries are connected (in parallel) to the Main Bus by a command in mission load

• Sunlight Operations

- At eclipse exit, batteries remain connected to the Main Bus to clamp the solar array voltage by absorbing surge currents of up to 35 amperes to maintain bus voltage within the 22 to 35 volt limits
- Once array temperature has stabilized (~15 minutes after eclipse exit), the batteries are disconnected from the bus
- Batteries are charged to a recharge ratio of ~ 1.05 (amp-hour integration)
- Once charged, batteries remain on trickle charge (via dedicated circuits)
- Battery tap (cell #16) provides backup emergency power capability

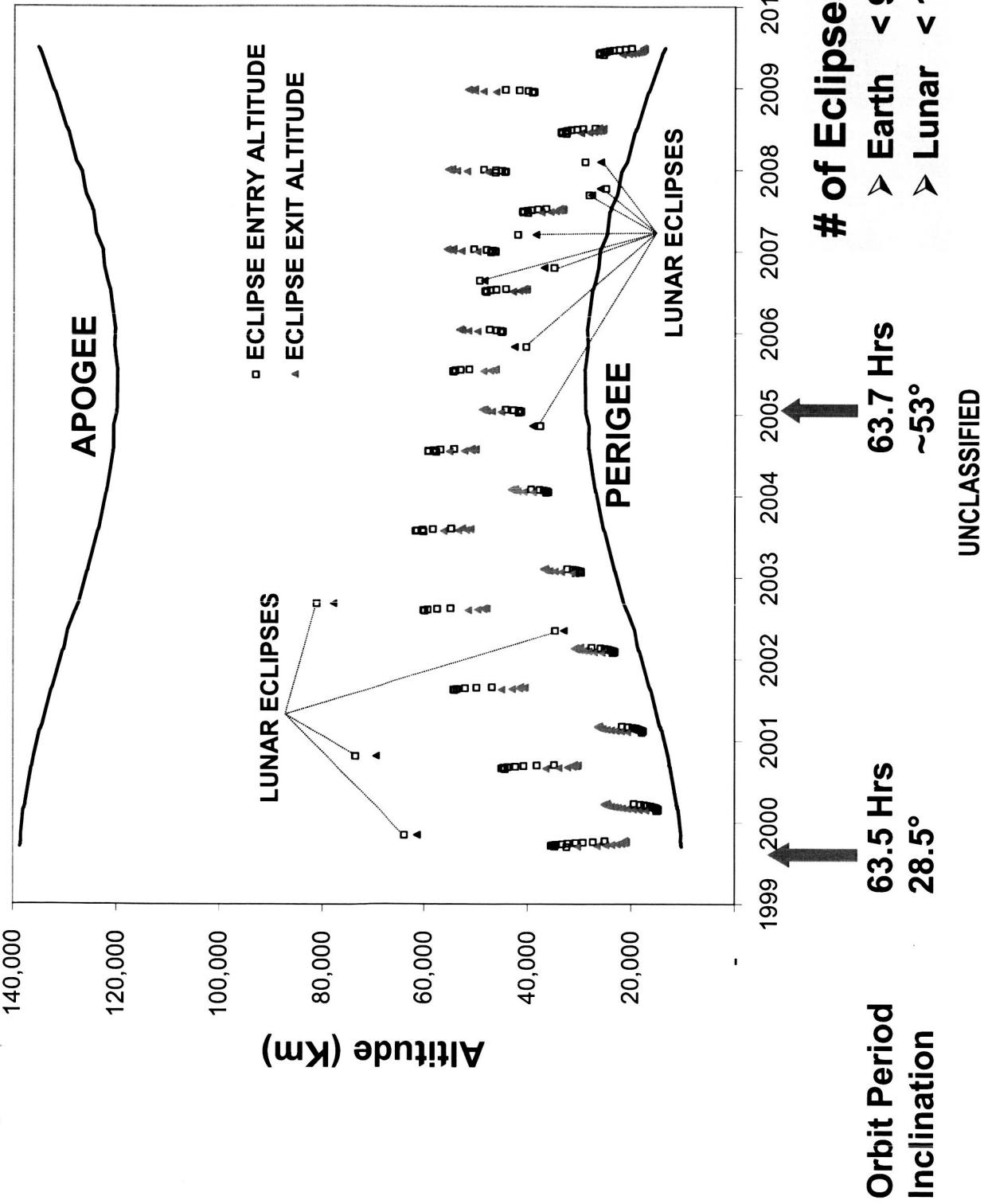
EPS control algorithms reside in the On-Board Computer

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Orbital Parameters

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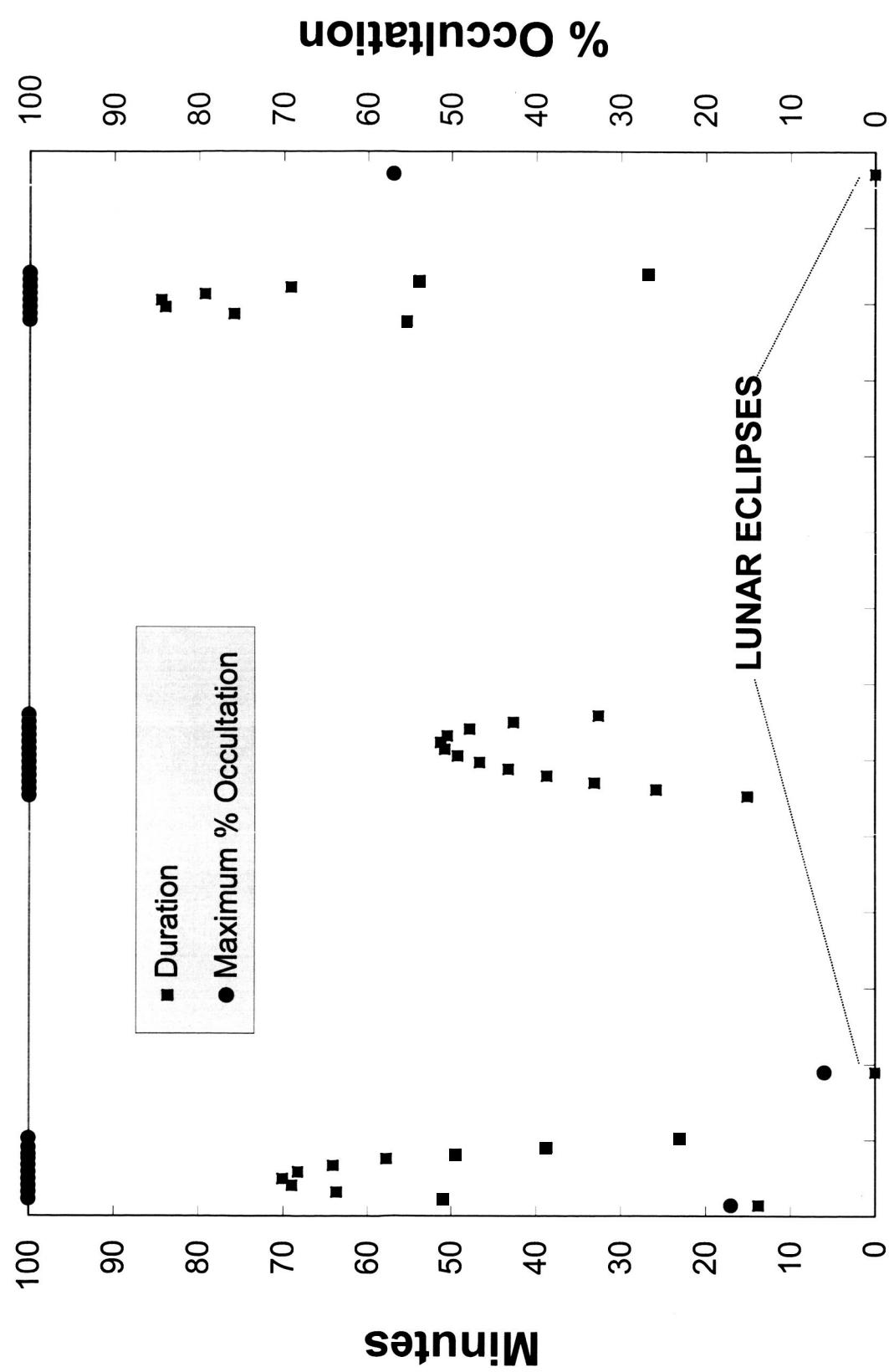


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Eclipse Duration & % Occultation



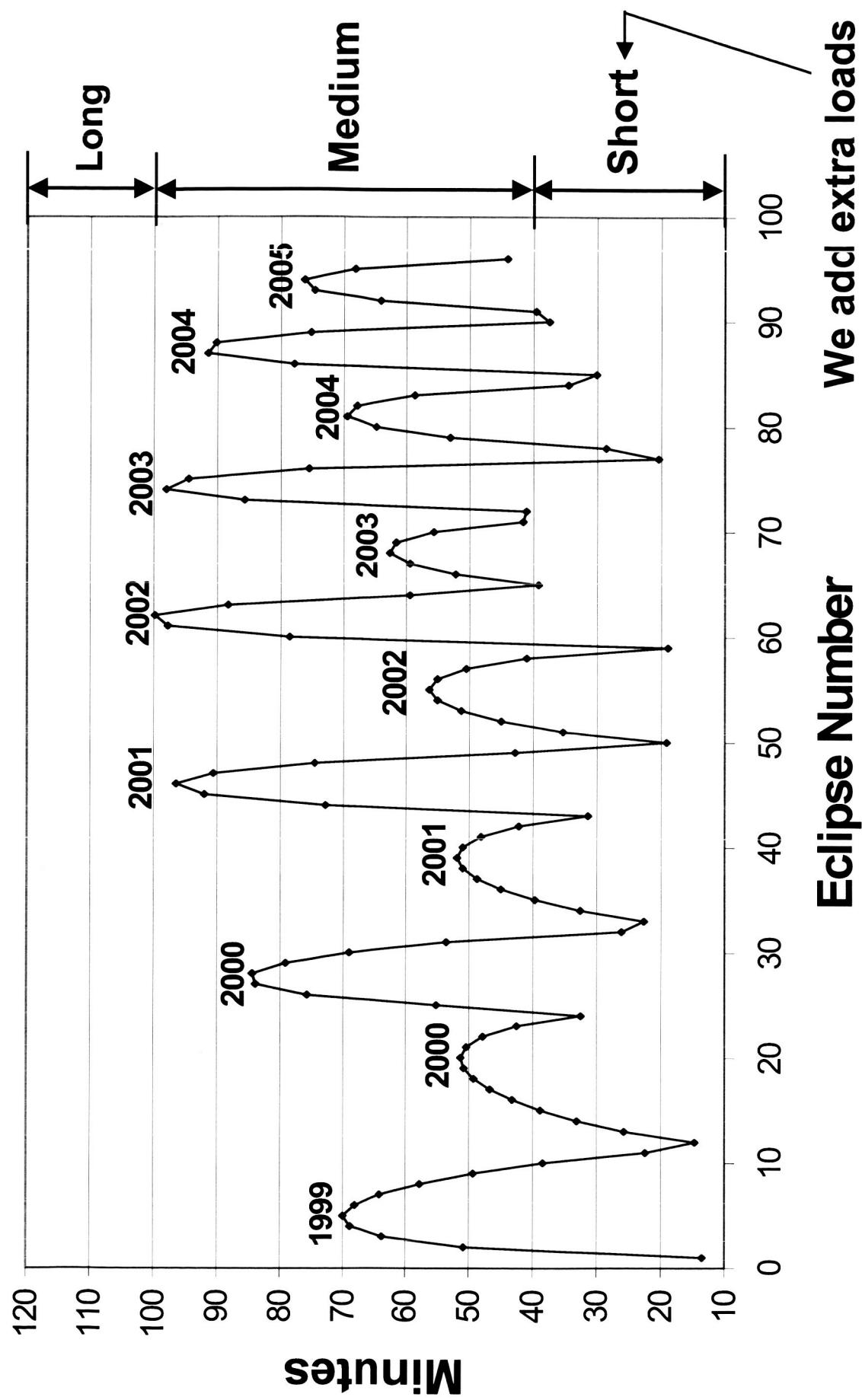
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Umbral Eclipse Categories

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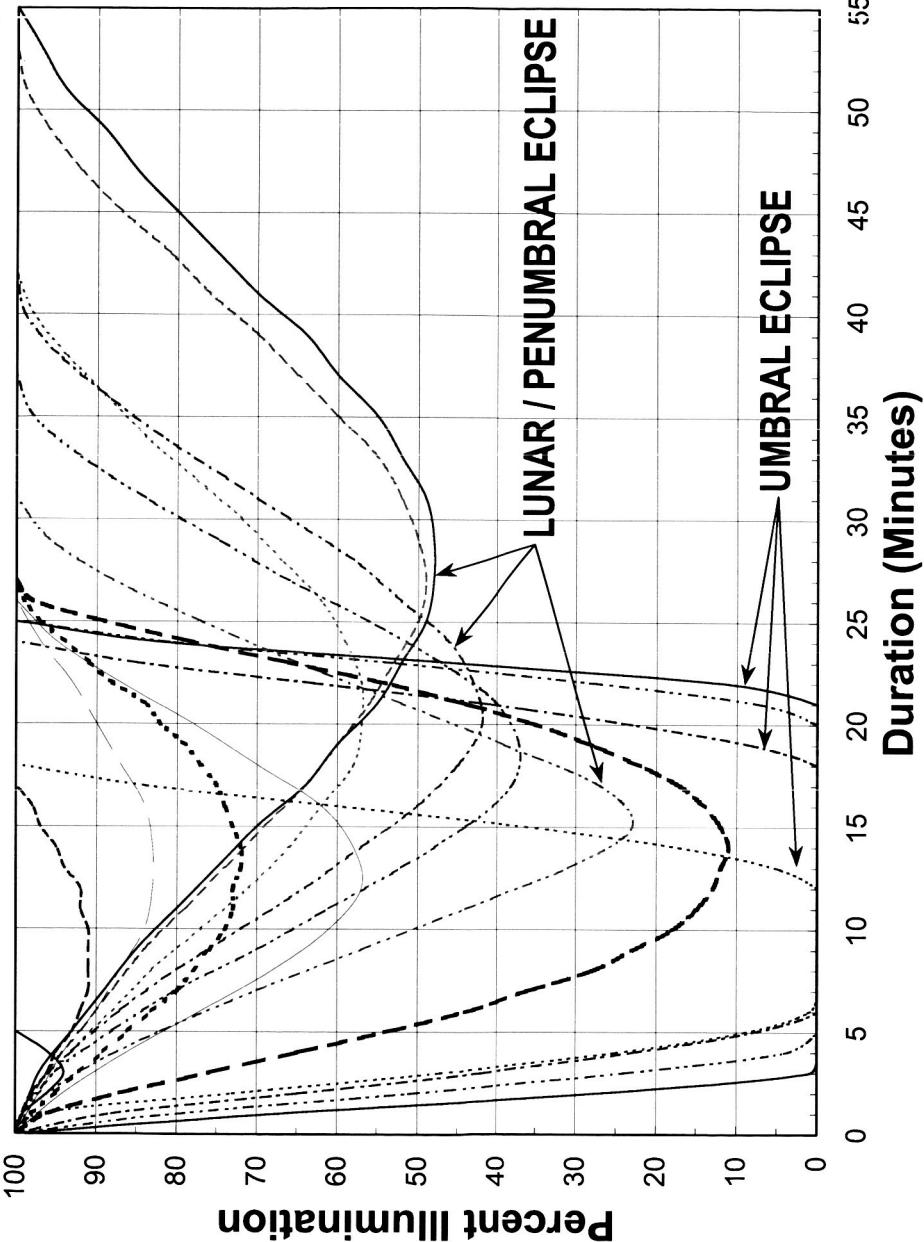
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Typical Penumbral Eclipses

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Category

Category	Action
Array temperature > 100 F	No Battery Connection (Fly-Through)
Array temperature < 100 F	Battery Connection, without Extra Loads
Array temperature < 100 F	Battery Connection, with Extra Loads
Array temperature < 100 F	Solar Array Off-Point

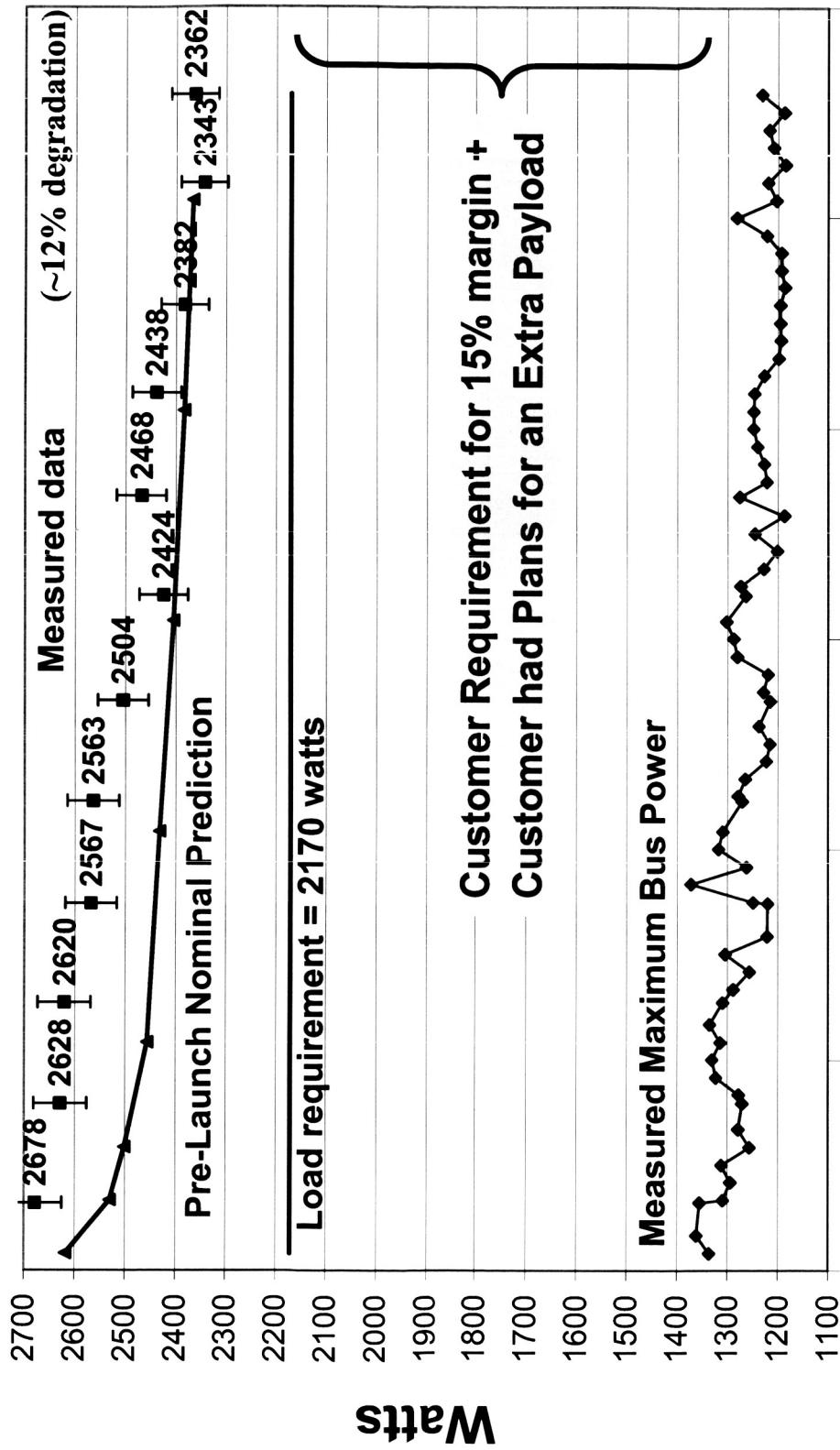
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Solar Array Capability

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Jun-99
Jun-00
Jun-01
Jun-02
Jun-03
Jun-04
Jun-05

Pre-launch margin is a plus at this stage of the mission

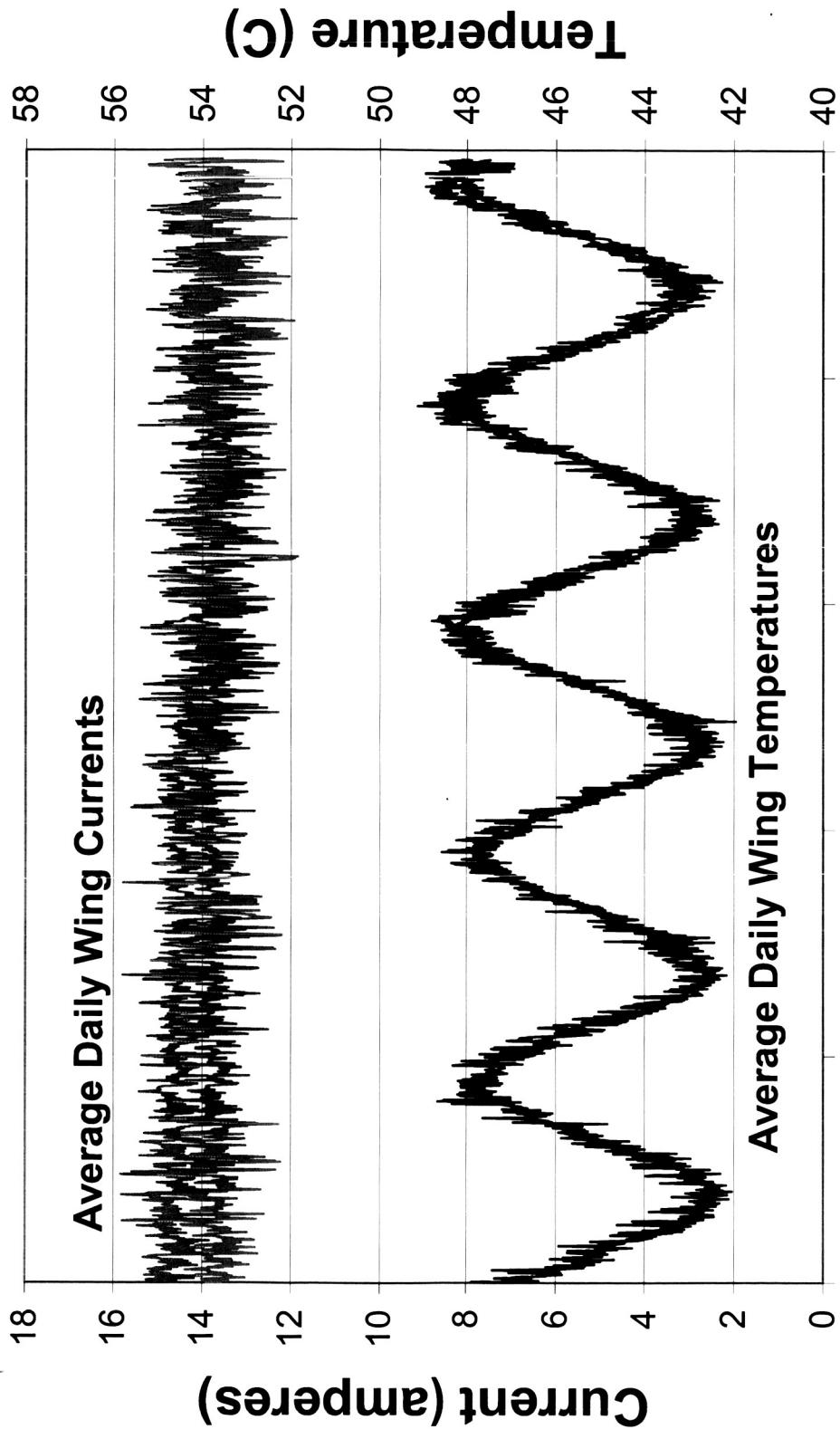
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Solar Array Performance

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Temperature (C)
T_{eb-05}
T_{eb-04}
T_{eb-03}
T_{eb-02}
T_{eb-01}
T_{eb-00}

Average Daily Wing Temperatures

Average Daily Wing Currents

Current (amperes)

Wing currents and temperatures have remained consistent

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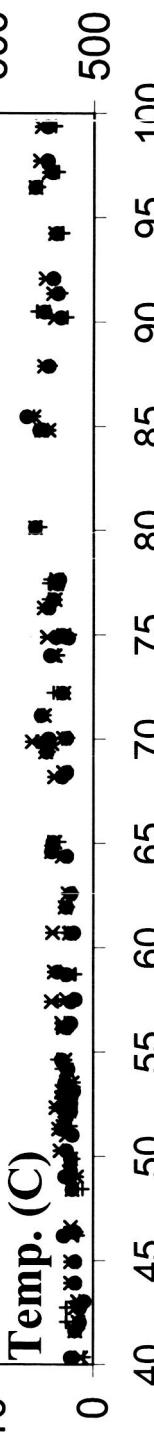
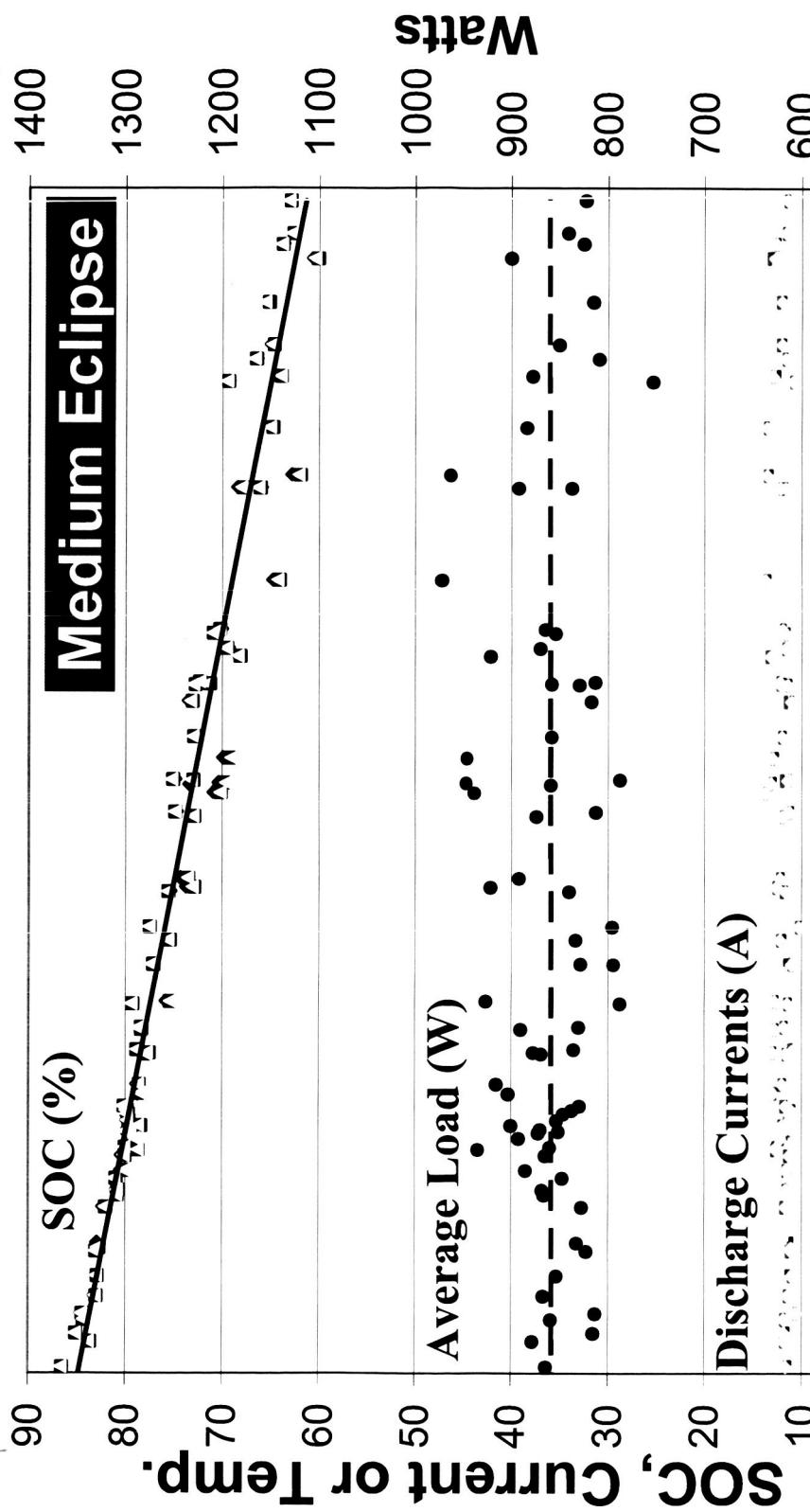
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Battery Discharge Performance

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Discharge performance of the 3 batteries is almost identical

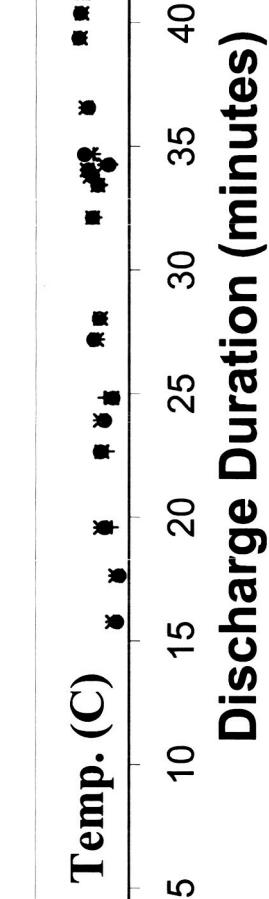
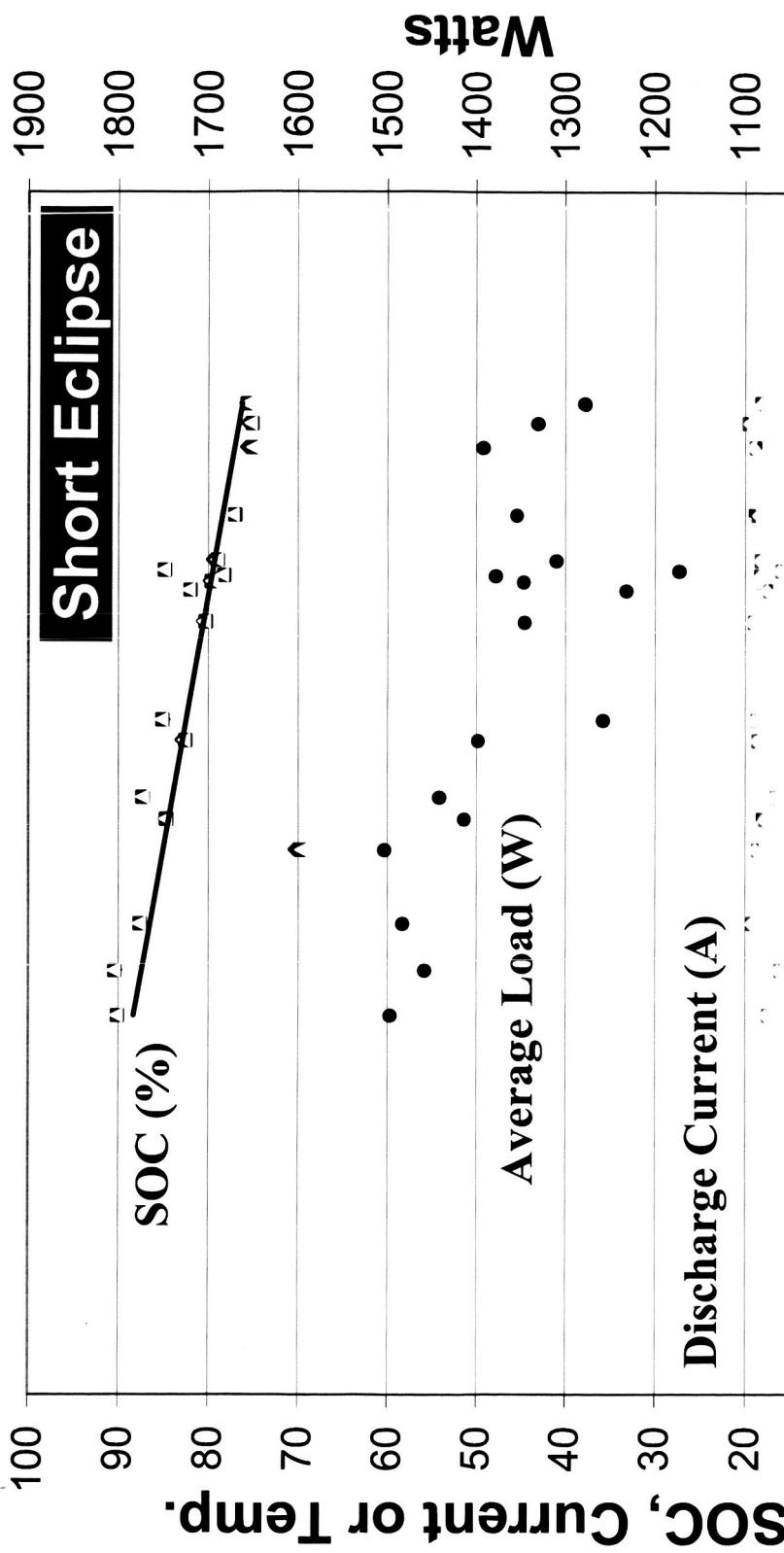
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Battery Discharge Performance

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Discharge performance of the 3 batteries is almost identical

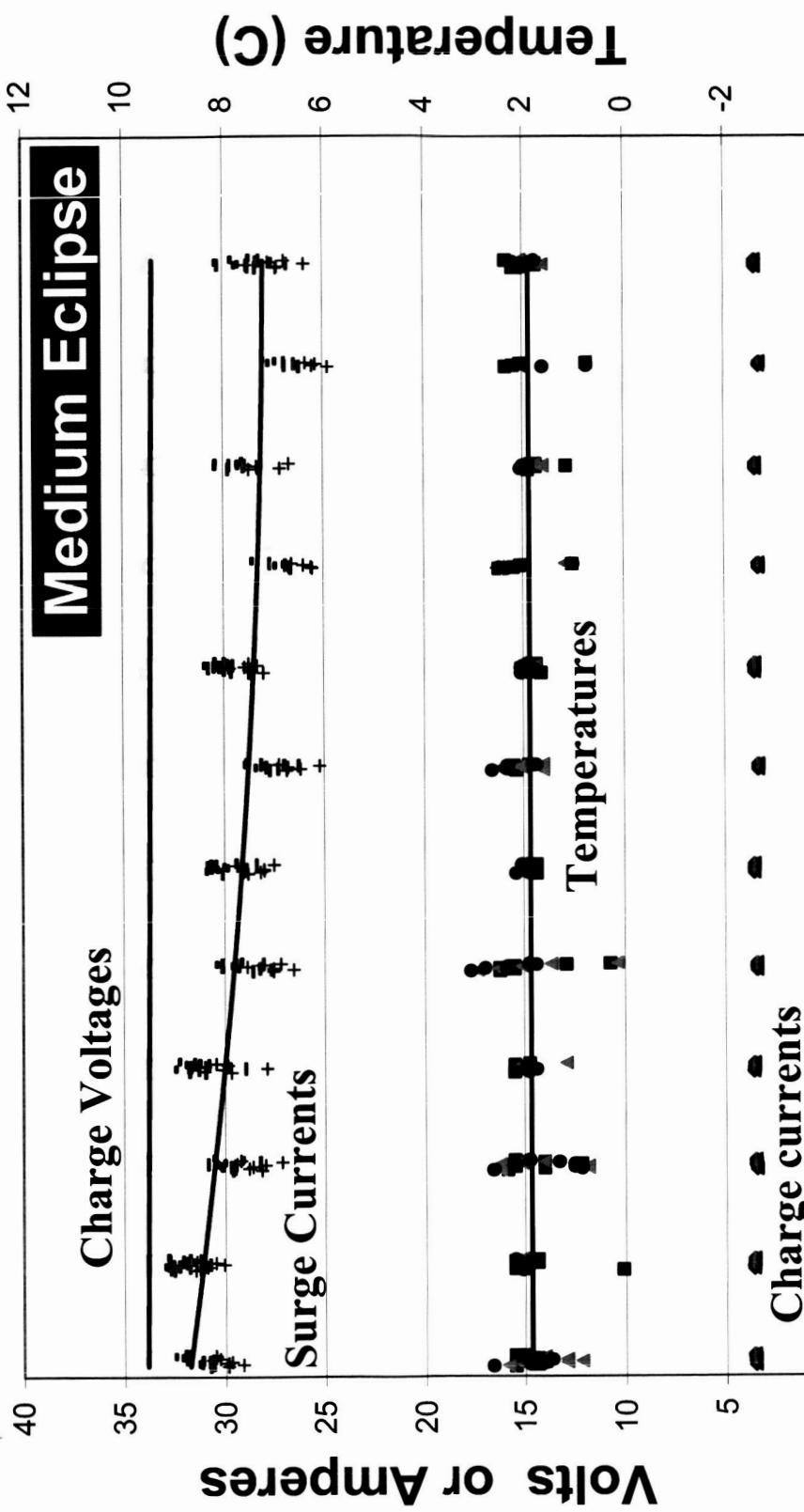
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Battery Charge Performance

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Charge performance of the 3 batteries is almost identical

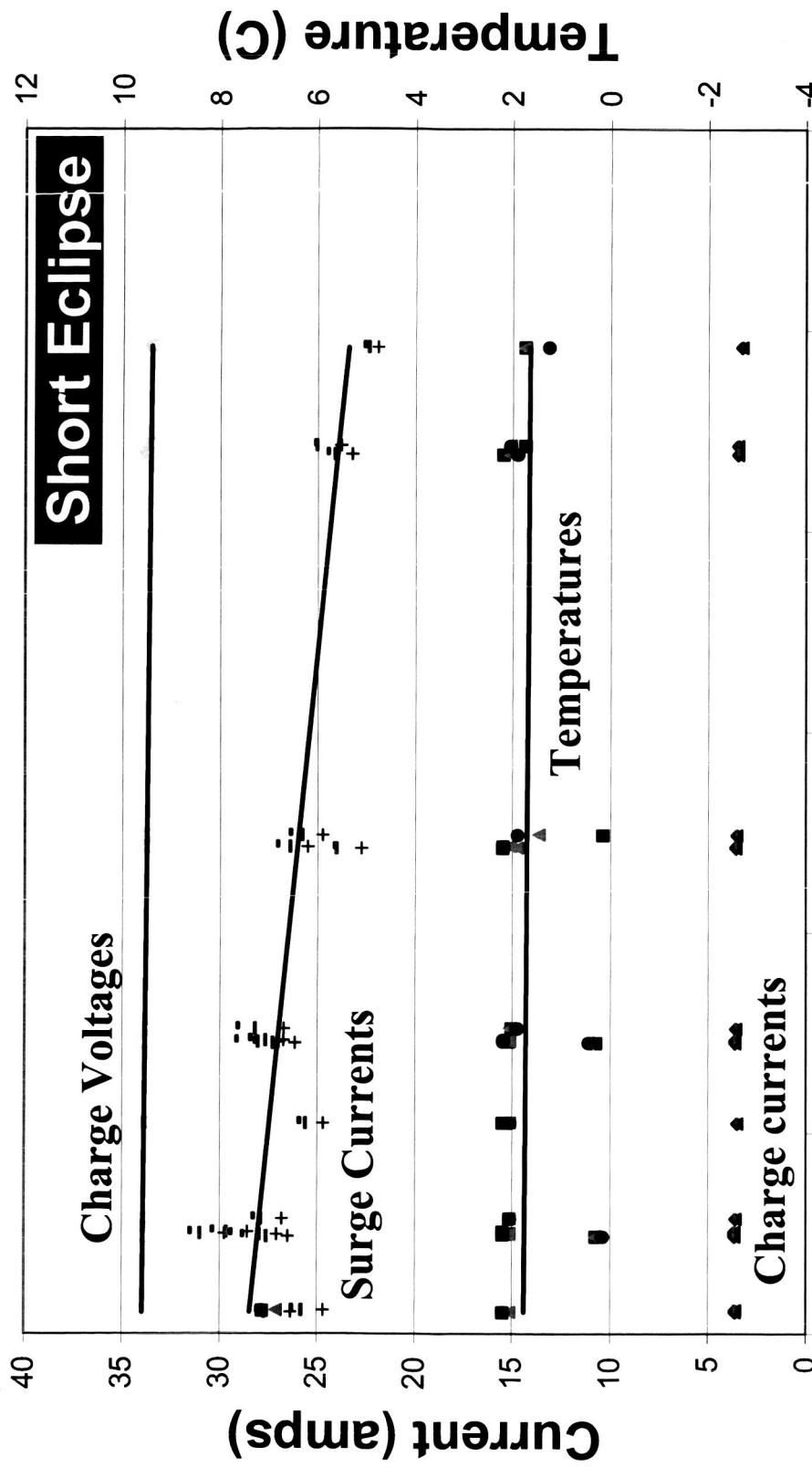
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Battery Charge Performance

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Charge performance of the 3 batteries is almost identical

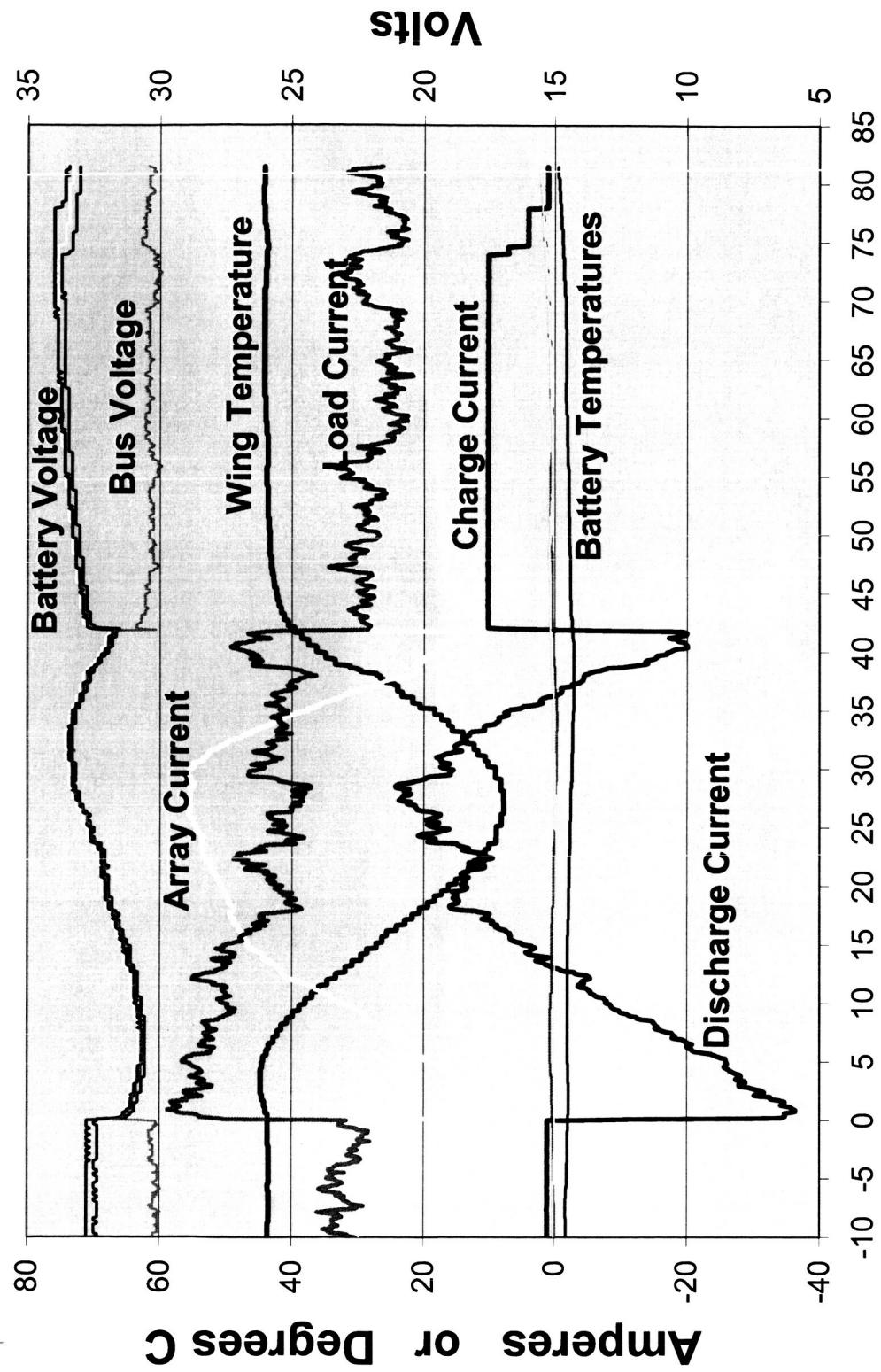
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Lunar Eclipse Performance

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Perfect sharing between the 3 batteries and the 2 wings

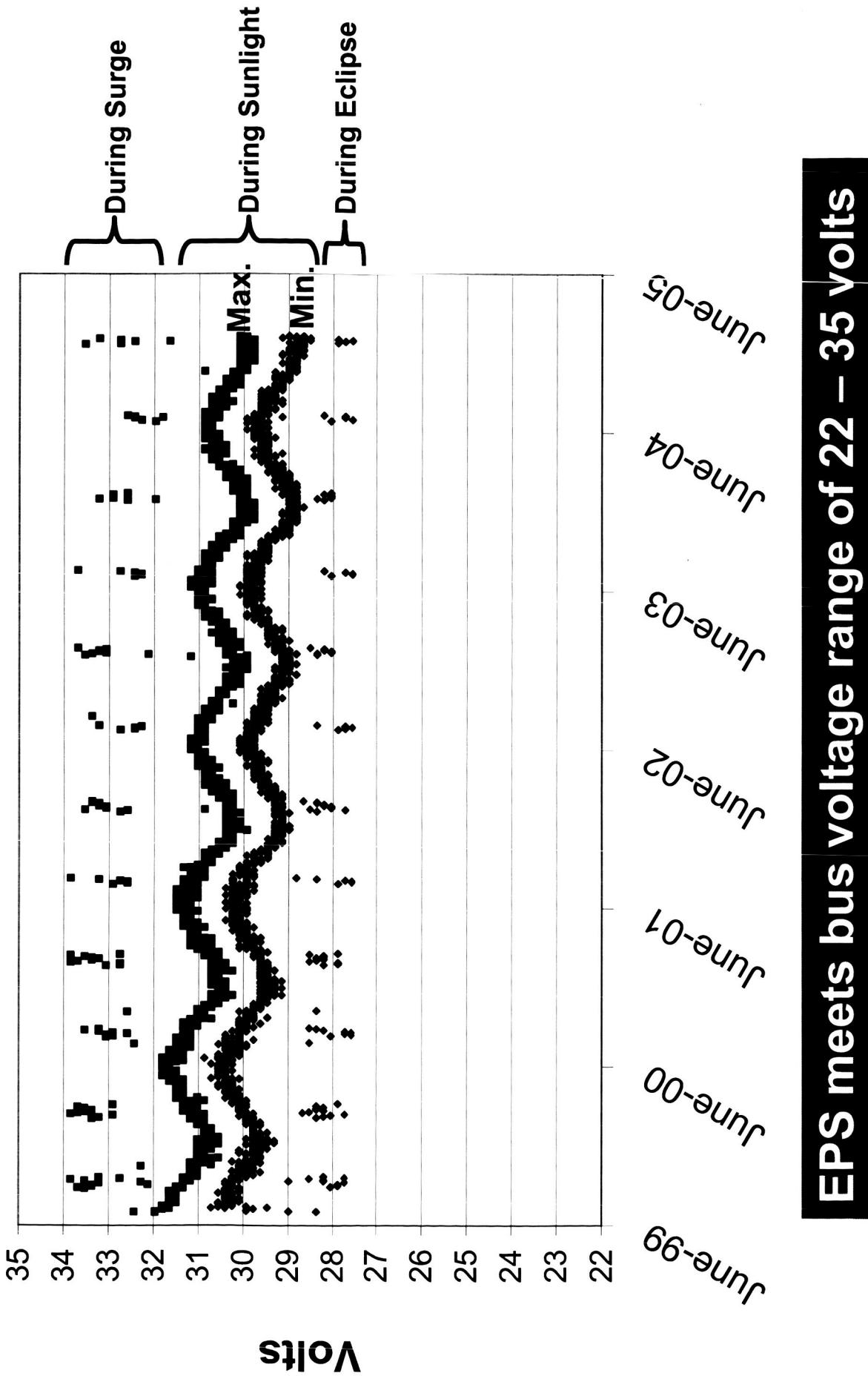
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Bus Voltage Performance

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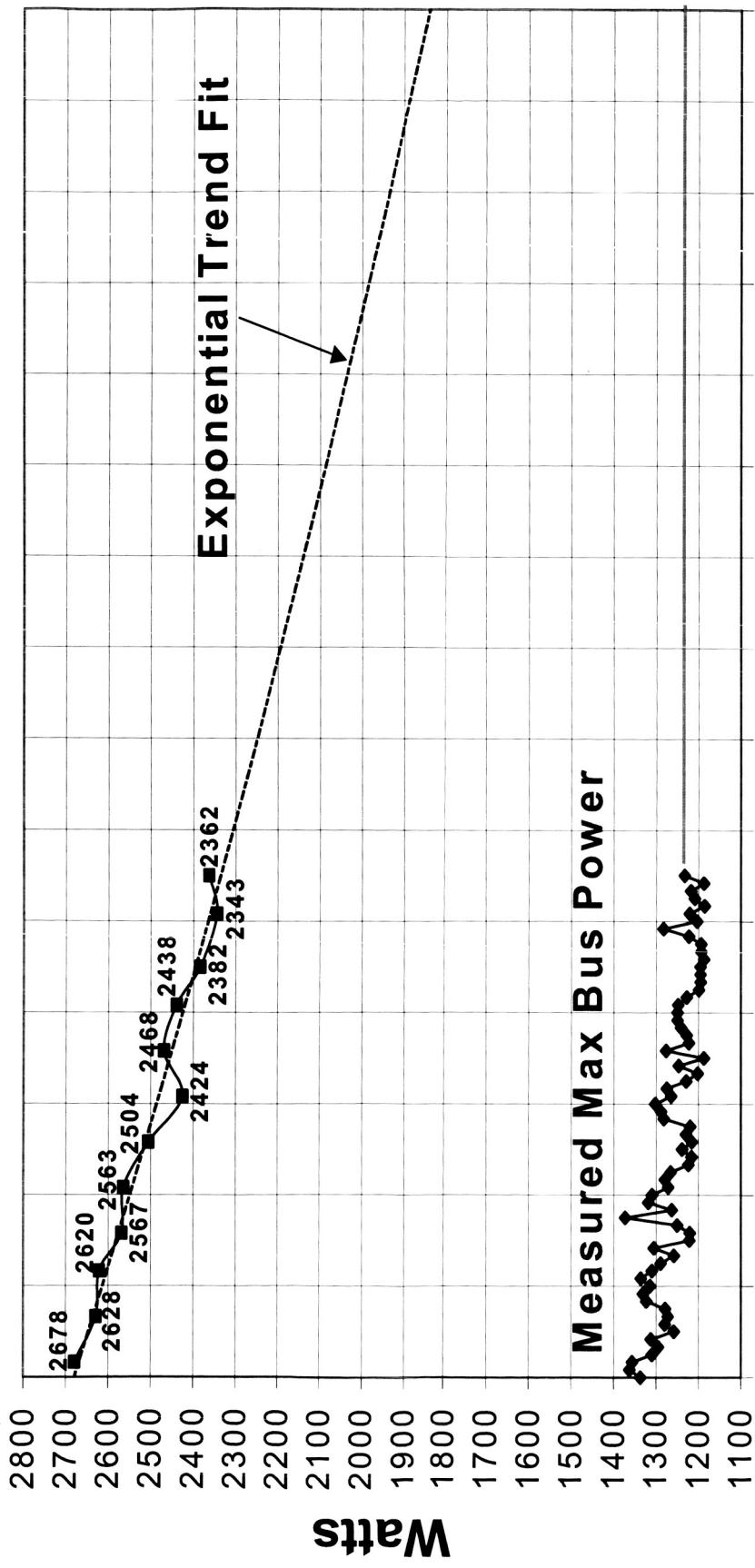


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Future Plans

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Due to an exemplary performance by all systems, mission life has been extended to 10 years min. (possibly 15 years)

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